EARTH ORBITER -1
Level II Configuration Control Board
CCR Distribution

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Date Issued: January 20, 1998
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Bicknell@ll/MIT	Hoffeld@ll/MIT
CWNICHOLS@CCGATE	BWKOPRA@CCGATE
PTBRYANT@CCGATE	

EO-1 Configuration Manager: Steve Schneider/CSC/GSFC
sschneider@hst.nasa.gov

NEW MILLENNIUM PROJECT CONFIGURATION CHANGE REQUEST

PROGRAM EO-1

CCR NO. 0006

DATE INITIATED 01/20/98

TITLE BASELINE ALI TO EO-1 SPACECRAFT RS-422 DATA ICD-056

ORIGINATOR GSFC Code 735

ORIGINATOR'S CHG. NO. EO-1 ICD-056

SPONSOR/CODE T. Smith/Code 735 **PHONE** x0651

EFFECTIVITY

ITEM: ALI
S / N

ITEM:
S / N

ITEM:
S / N

CHANGE CLASS

	I	II
PRELIMINARY	☐	☐
FORMAL	☐	☐

TYPE OF CHANGE

MILESTONE	☐	INTERFACE	☒	SOFTWARE	☐
DOCUMENT	☒	POWER	☐	OTHER	☐
COST ____	☐	WEIGHT	☐	____	☐

DOCUMENTS OR SOFTWARE AFFECTED

EO-1 ICD-056

PROBLEM

The attached draft version of EO1-ICD-056, Earth Orbiter -1 (EO-1) Advanced Land Imager (ALI) to EO-1 Spacecraft RS-422 Data Interface Control Document (ICD) requires baselining. The document defines the functional, physical and electrical characteristics of the ALI that impacts the EO-1 spacecraft on which it will be integrated.

PROPOSED SOLUTION

Approve the attached draft version of EO-1 ICD-056, ALI to EO-1 Spacecraft RS-422 Data ICD by the EO-1 Level II Configuration Control Board (CCB). This draft issue will be formally released after CCB approval. Future changes will be initiated by submittal of Configuration Change Requests (CCRs) and Preliminary Interface Revision Notices (PIRNs) for CCB approval. This document is maintained by the EO-1 Configuration Management Office (CMO).

BOARD ACTION

- APPROVE ☑
- APPROVE WITH CHANGE ☐
- DISAPPROVE ☐
- WITHDRAW ☐

APPROVAL LEVEL REQUIRED

- LEVEL I HQS ☐
- LEVEL II GSFC ☒
- LEVEL III ☐

CRITICALITY LEVEL

- EMERGENCY ☐
- URGENT ☐
- ROUTINE ☒

PROCUREMENT CHANGE ORDER CLASSIFICATION

ROUTINE		URGENT		EMERGENCY ☐
OPTION 1	☐	OPTION 1	☐	
OPTION 2	☐	OPTION 2	☐	

COMMENTS

Approve to baseline ICD-56

CHAIRPERSON [signature]

DATE 30 ~~MAY~~ March 98

3/28/96

EO-1 ICD-56
Draft Issue
January 20, 1998

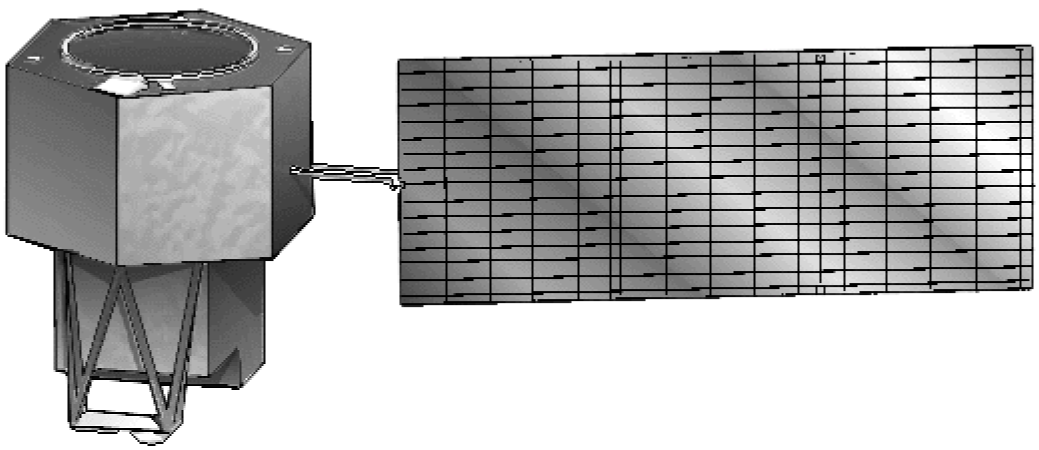
EO-1
ADVANCED LAND IMAGER
(ALI)
TO
SPACECRAFT
RS-422 DATA
INTERFACE CONTROL DOCUMENT
(ICD)

National Aeronautics and
Space Administration

Goddard Space Flight Center
Greenbelt, Maryland

ICD-056
Draft
January 20, 1998

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GODDARD SPACE FLIGHT CENTER



Earth Orbiter 1

ALI to Spacecraft
RS-422 Data Interface Control Document

WARP7350026

Prepared by
Joy Bretthauer

January 15, 1998

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REVISION HISTORY

Preliminary Version 3/17/97	• Initial creation; Bruce Zink
Revision 1 4/23/97	• First Revision; Joy Bretthauer
Revision 2 5/23/97	• Second Revision, Joy Bretthauer • renamed DB78 pin assignments, designated GSFC DB78 part numbers
Revision 3 6/16/97	• Third Revision, Joy Bretthauer • excluded AC sections for MIT sign-off; included Ron Hoffeld's (MIT\LL) comments; defined Word Header Definition; updated diagrams
6/23/97	• WARP7350026, Joy Bretthauer • Includes WARP reviewers' comments
11/19/97	• WARP7350026, Joy Bretthauer • Removed ALI Appendix ; referenced ALI-S1002 (8/29/97)
01/7/98	• Includes MIT & WARP reviewer's comments • Name changed from ALI RS-422 to FODB/WARP to ALI Spacecraft RS-422 Data Interface Control Document

Instrument Interface RS-422 Issues List

MIT\LL Issues

1. MS/PAN data format: WARP is designed to use only one frame sync pattern. Since there is no way to guarantee whether the MS or PAN occurs first in the multiplexed MS/PAN data stream, MIT now requires distinct MS and PAN channel identifiers. **closed**
2. MIT\LL was informed on April 21, 1997 that their external RS-422 connectors will be DB78. **closed**

WARP Issues	**Closing Date**
1. RS-422 testbed to analyze terminations, timing, cable lengths	**closed**
2. WARP RS-422/WARP FODB board area study for connectors	**closed**

To Be Determined (TBD) List

1. Max frames per second/Data Storage: maximum frames per second from ALI with dead words stored in the memory; current plan assumes Instrument FODB terminal and WARP's RS-422 card will filter dead words
   Response: WARP/FODB must filter dead words to meet data rate requirements. Max frames with dead words stored in the memory is zero. **closed**

2. Maximum number of connector Mate/De-mates 1/30/98

3. RS-422 maximum cable length permitted for reliable EO-1 science data transmission. **closed**

4. MS/PAN: new data storage requirement (3/30/97) - MIT\LL requests unique MS and PAN channel identifiers. differentiate the MS data from; impact on WARP/FODB designs, memory storage scheme; MS/PAN data rate & storage (minimal) **closed**

5. Maximum differential delay between any two RS-422 transmitters \ receivers TBD: Litton \ GSFC
   Based upon thermal analysis (operating temp.), part specifications, timing requirements

6. Thermal analysis by Litton: RS-422 receiver/transmitter operating temperatures TBD: Litton

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TABLE OF CONTENTS

1 OVERVIEW

1.1 Scope

This document defines the RS-422 Data Interface between the EO-1 Advanced Land Imager (ALI) instrument and the EO-1 spacecraft. The RS-422 Data Interface between the EO-1 Atmospheric Corrector instrument and the EO-1 spacecraft is defined in a separate document.

1.2 Supporting Documents

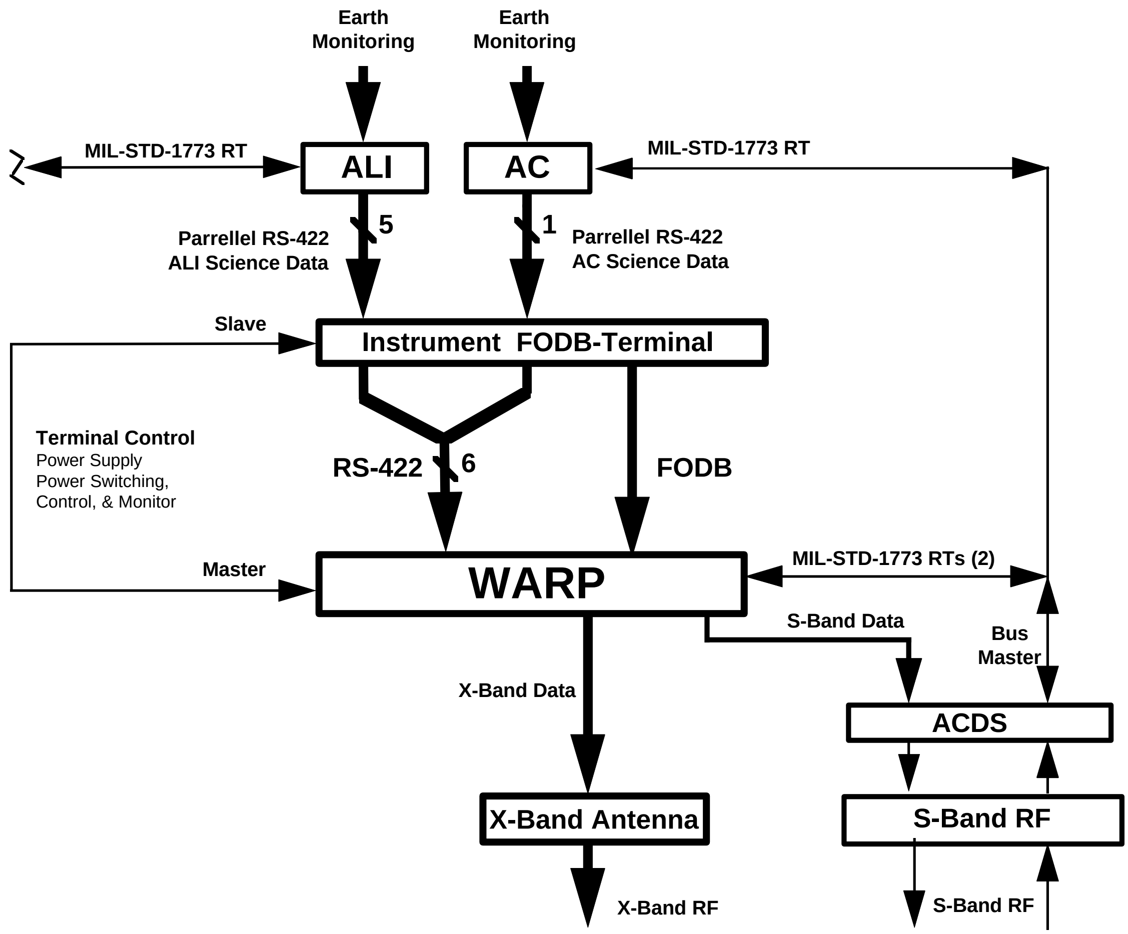
Spec ID	Title	Source	Date
ALI-S1002	Focal Plane Subsystem to Instrument Interface Control document (EO-1 Advanced Land Imager)	MIT/LL	8/29/97
AM-149-0020(155)	System Level Electrical Requirements New Millennium Program Earth Orbiter-1 Flight	Litton Amecom	12/13/96
	EO-1 Advanced Land Imager Design Convergence Review	EO-1 Web Page	1/29/97
EIA-422-B	Electrical Characteristics of Balanced Voltage Digital Interface Circuits	EIA	5/94
TBD#; Rev. D	WARP to Ground ICD	GSFC	5/30/97

1.3 Requirements

Figure 1 shows the EO-1 Flight Data System Architecture. The RS-422 Data Interface transfers raw high rate science data from the ALI to the spacecraft. Specifically, the RS-422 Data Interface transfers science data from the ALI's Focal Plane Electronics (FPE) to the spacecraft's Instrument Fiber Optic Data Bus (FODB) Terminal and Wideband Advanced Recorder Processor (WARP).

The RS-422 Data Interface can operate in the following configurations: 1) ALI to WARP via a passive feed-through in the powered-down Instrument FODB Terminal, 2) ALI to Instrument FODB Terminal, where the RS-422 Data Interface is converted to an FODB Interface, and 3) ALI to WARP through a direct connection, which would occur if the Category-3 Instrument FODB Terminal is not integrated into the spacecraft.

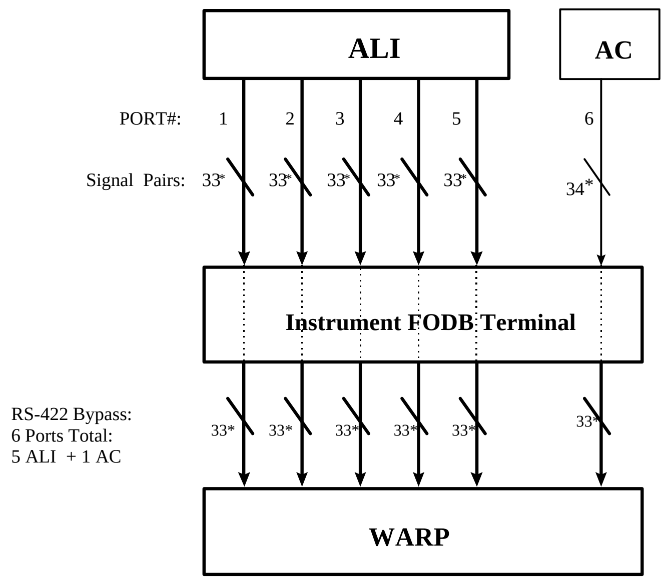
Figure 1. EO-1 Flight Data System Architecture



1.4 Interface Description

1.4.1 ALI RS-422 Interface Description

Figure 2 illustrates the interfaces from the ALI to either the FODB or WARP.



Notes:

1) * Denotes RS-422 twisted shielded pair. Each data port has 32 data lines and 1 clock

2) Port Designations:
PORT 1 => MS/PAN (ALI PORT A) PORT 4 => VNIR GIS (ALI PORT D)
PORT 2 => VNIR WIS (ALI PORT B) PORT 5 => SWIR GIS (ALI PORTE)
PORT 3 => SWIR WIS (ALI PORT C) PORT 6 => Atmospheric Corrector ; not defined here

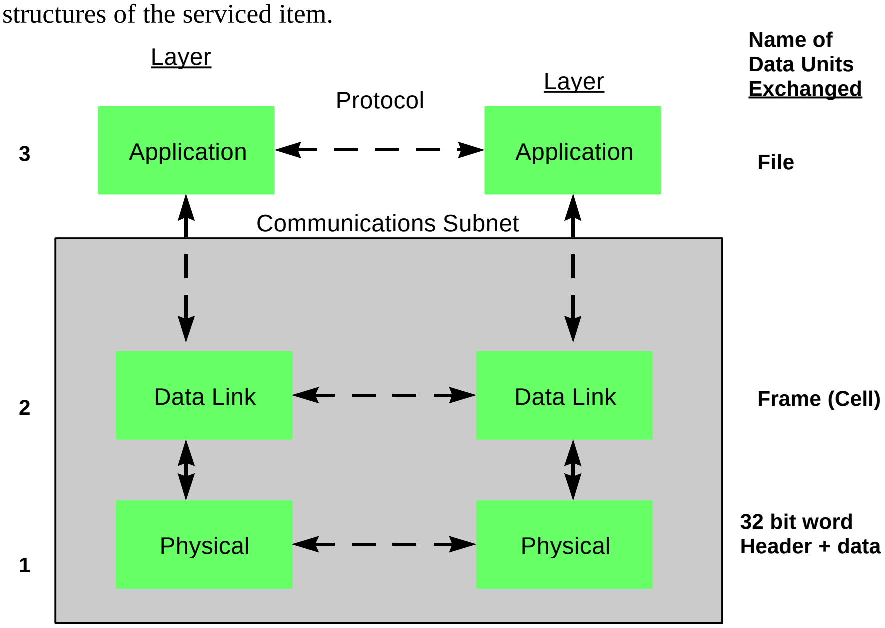
Figure 2

Five separate RS-422 parallel data interfaces, each corresponding to a particular detector, exist between the ALI and the spacecraft: MS/PAN (3.2MHz), WIS VNIR (4.8 MHz), WIS SWIR (9.6 MHz), GIS VNIR (4.8 MHz), and GIS SWIR (9.6 MHz). In Figure 2, each data interface is assigned a port number. Whenever the ALI's focal plane assembly is commanded to transmit data, all 5 ALI ports will be active.

Each data port contains 1 clock line and 32 data lines. Data is transferred sequentially across the port in 32 bit parallel data words. Each word consists of 24 bits of pixel data (two 12 bit pixels) and 8 bits of auxiliary data. The data format will be transferred in its "raw" form across the interface. The WARP and FODB Terminal shall not be powered simultaneously. During any data collection mode, only one RS-422 receive interface (the WARP or the FODB Terminal) shall be powered. WARP and FODB Terminal operation shall be invariant to ALI data collection modes. For all ALI sensors, except the MS/PAN, "dead words" located within each valid frame shall be filtered. The WARP and FODB Terminal "dead word" filtering scheme shall remain constant throughout all science data acquisition, test pattern, and calibration modes.

1.5 Interface Layers Description

This document will use a modified Open Systems Interconnect (OSI) standard model which describes an interface between two systems. Each system performs functions which can be described as a series of layers. Each system has the same number and function of layers, and the equivalent layers for each system communicate via an established protocol which is transparent to the protocols at other layers. Each system passes data from its upper layers to the lower layers via a service provided by the next lower layer. OSI uses seven layers to describe an interface, for the purpose of this document we will use three layers: the Physical Layer (Layer 1), the Data Link Layer (Layer 2), and the Application Layer (Layer 3). The first two layers are identical to those of the OSI standard, and the third layer corresponds to the application specific data structures of the serviced item.



2 Physical Layer

2.1 Physical Layer Function

The Physical Layer consists of two parts: the physical layer medium (the cabling and connectors, etc. that make up the physical connection between the two systems) and the physical layer protocol which defines the lowest level of formatting (bit-level) of the data.

2.2 Cable Type

2.2.1 Maximum Cable Length\Terminations

The maximum, 24 AWG twisted-shielded pair, cable length from the ALI to the WARP on the EO-1 spacecraft is 12 feet. The maximum cable length includes the length between the entry and exit connectors within the FODB Instrument terminal. Maximum cable lengths were determined from the RS-422 test bed results (6/30/97) and EIA-RS-422 standard. In addition, all wires used within the same port (parallel word interface) shall be routed along the same path, assuring similar cable lengths for all bits within the same words. With the exception of the SWIR WIS/GIS clock signals, all WARP RS-422 receiver termination impedances shall be AC coupled with 120 ohm resistor values in series with 100 picofarad capacitor values. The SWIR WIS/GIS clocks will be terminated with 120 ohm resistors. Termination impedance values were determined from the RS-422 test bed results (6/30/97).

2.2.2 Wire Gauge and Impedance

Each signal shall be conveyed via 24 AWG twisted shielded pair cable. The characteristic impedance of the twisted shielded pair cables shall be 120 ohms.

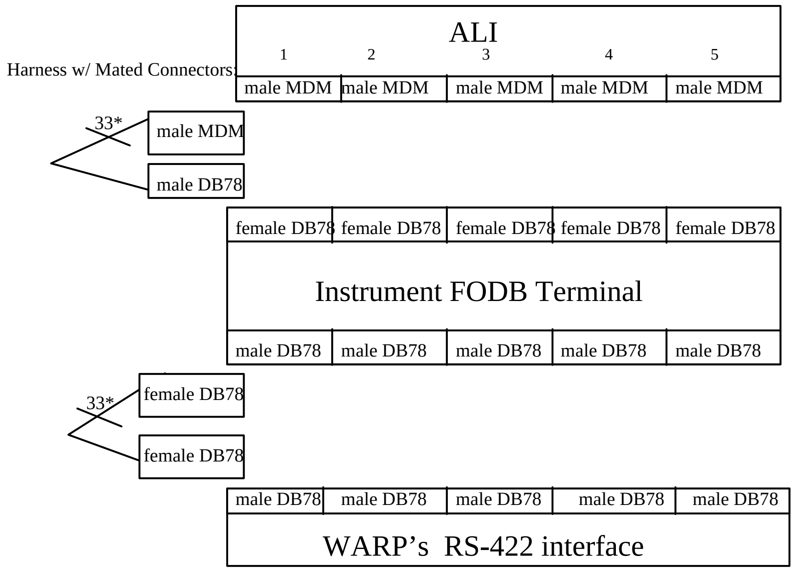
2.2.3 Shield Connections

All shields shall be terminated to the backshells of the connectors on both ends of the harness run. Both ends of each RS-422 cable between the ALI and the FODB Instrument Terminal shall have backshells. Due to space limitations, both ends of the RS-422 cable between the WARP and the Instrument FODB Terminal, shall be terminated with conductive tape.

2.3 Connector Type

Five male DB78 connectors interface the ALI data ports with the Instrument FODB Terminal. Each ALI data port shall mate to the EO-1 spacecraft via a harness with an MS24308 series, DB78 connector. All male type connectors shall have the GSFC Part # 311P407-5P-B-12. All female type connectors shall have the GSFC part number 311P407-5S-B-12. The Instrument FODB Terminal shall have female-type, DB78 connectors, requiring the harness to utilize mating male-type, DB78 connectors. The Instrument FODB Terminal's RS-422 bypass shall have male-type connectors, requiring the harness to utilize mating female-type connectors. The WARP's RS-422 interface shall have male-type DB78 connectors, requiring the harness to utilize mating female-type DB78 connectors. Due to limited connector space, the harness's female-type DB78 connectors which mate to the WARP's RS-422 interface shall not have EMI backshells. A block diagram of the connector types is illustrated in Figure 3.

Figure 3



* Denotes RS-422 twisted shielded pair. All ports within a box will have the same type matching harness connectors. Each ALI port shall have a harness with a mated male connector. Each WARP port shall have a harness with a mated female connector. Each IFT port which interfaces to the ALI shall have a harness with a mated male connector. Each IFT port which interfaces to the WARP shall have a harness with a mated female connector.

2.3.1 Connector Pin-Out

For ALI 100 MDM connector pinouts, reference document ALI-S1002.
The following table lists the pin-outs of the Instrument FODB Terminal's RS-422-to-ALI connectors, the Instrument FODB Terminal' RS-422-to -WARP connectors and the WARP's RS-422-to-Instrument FODB Terminal RS-422 connectors . The pinouts of the ALI science data interface can be found in the EO1-ALI Specification ALI-S1002.

Table 1

WP"N" is WARP Port 1-5, where 1, 2, 3, 4 or 5 replaces "N"

Pin #	Signal Name	Description
1	WP"N"DB00P	Data bit 0 - MSB positive
20	NC	no connect
21	WP"N"DB00N	Data bit 0 - MSB negative
2	WP"N"DB01P	Data bit 1 - positive
22	WP"N"DB01N	Data bit 1 - negative
3	WP"N"DB02P	Data bit 2 - positive
23	WP"N"DB02N	Data bit 2 - negative
4	WP"N"DB03P	Data bit 3 - positive
24	WP"N"DB03N	Data bit 3 - negative
5	WP"N"DB04P	Data bit 4 - positive
25	WP"N"DB04N	Data bit 4 - negative
6	WP"N"DB05P	Data bit 5 - positive

26	WP”N”DB05N	Data bit 5 - negative
7	WP”N”DB06P	Data bit 6 - positive
27	WP”N”DB06N	Data bit 6 - negative
8	WP”N”DB07P	Data bit 7 - positive
28	WP”N”DB07N	Data bit 7 - negative
9	WP”N”DB08P	Data bit 8 - positive
29	WP”N”DB08N	Data bit 8 - negative
10	WP”N”DB09P	Data bit 9 - positive
30	WP”N”DB09N	Data bit 9 - negative
11	WP”N”DB10P	Data bit 10 - positive
31	WP”N”DB10N	Data bit 10 - negative
12	WP”N”DB11P	Data bit 11 - positive
32	WP”N”DB11N	Data bit 11 - negative
13	WP”N”DB12P	Data bit 12 - positive
33	WP”N”DB12N	Data bit 12 - negative
14	WP”N”DB13P	Data bit 13 - positive
34	WP”N”DB13N	Data bit 13 - negative
15	WP”N”DB14P	Data bit 14 - positive
35	WP”N”DB14N	Data bit 14 - negative
16	WP”N”DB15P	Data bit 15 - positive
36	WP”N”DB15N	Data bit 15 - negative
17	WP”N”DB16P	Data bit 16 - positive
37	WP”N”DB16N	Data bit 16 - negative
18	WP”N”DB17P	Data bit 17 - positive
38	WP”N”DB17N	Data bit 17 - negative
19	WP”N”DB18P	Data bit 18 - positive
39	WP”N”DB18N	Data bit 18 - negative
40	NC	no connect
41	NC	no connect
42	NC	no connect
43	NC	no connect
44	NC	no connect
45	WP”N”DB19P	Data bit 19 - positive
65	WP”N”DB19N	Data bit 19 - negative
46	WP”N”DB20P	Data bit 20 - positive
66	WP”N”DB20N	Data bit 20 - negative
47	WP”N”DB21P	Data bit 21 - positive
67	WP”N”DB21N	Data bit 21 - negative
48	WP”N”DB22P	Data bit 22 - positive
68	WP”N”DB22N	Data bit 22 - negative
49	WP”N”DB23P	Data bit 23 LSB- positive
69	WP”N”DB23N	Data bit 23 LSB- negative
50	WP”N”DB24P	Data bit 24 - positive Band ID lsb
70	WP”N”DB24N	Data bit 24 - negative Band ID lsb
51	WP”N”DB25P	Data bit 25 - positive Band ID
71	WP”N”DB25N	Data bit 25 - negative Band ID
52	WP”N”DB26P	Data bit 26 - positive Band ID
72	WP”N”DB26N	Data bit 26 - negative Band ID
53	WP”N”DB27P	Data bit 27 - positive Band ID msb
73	WP”N”DB27N	Data bit 27 - negative Band ID msb

54	WP”N”DB28P	Data bit 28 - positive Quadrant lsb
74	WP”N”DB28N	Data bit 28 - negative Quadrant lsb
55	WP”N”DB29P	Data bit 29 - positive Quadrant msb
75	WP”N”DB29N	Data bit 29 - negative Quadrant msb
56	WP”N”DB30P	Data bit 30 - positive Line Start
76	WP”N”DB30N	Data bit 30 - negative Line Start
57	WP”N”DB31P	Data bit 31 - positive Dead Column
58	NC	no connect
59	NC	no connect
60	NC	no connect
63	NC	no connect
64	NC	no connect
77	WP”N”DB31N	Data bit 31 - negative Dead Column
78	NC	no connect
61	WP”N”CLKP	Port Clock - positive
62	WP”N”CLKN	Port Clock - negative

2.4 Bit Level Timing

Every ALI data port has a 32 bit data word. Due to electrical variations in the RS-422 transmitters, the bit level timing of each word may differ from port to port. Throughout the ALI’s operating temperature range, the timing skew between any two RS-422 transmitters, within the same data port, shall not exceed 10 nanoseconds. Differential delays between data signals within a given data port (from the ALI) will cause bit arrival time variations at the FODB/WARP RS-422 receivers.

Throughout the WARP and FODB operating range (-10^{o}C to 40^{o}C), the timing skew between any two FODB/WARP RS-422 receivers, within the same data port, shall not exceed 10 nanoseconds. The 10 nanosecond timing skew maximum is based upon 26C31 transmitter and 26C32 receiver test data over various temperatures (-55^{o}C, 25^{o}C, & 125^{o}C), provided by Harris Semiconductor.

2.4.1 Rise Time

The rise time (at the output of the generating source) shall be less than 20ns, as required by EIA-422-B.

2.4.2 Fall Time

The fall time (at the output of the generating source) shall be less than 20 ns, as required by EIA-422-B.

2.4.3 Clock Frequency

The ALI’s data port clock output rates are as follows: 3.2 MHz (MS/PAN); 4.8 MHz (WIS\GIS VNIR); 9.6 MHz WIS\GIS SWIR.

2.4.4 ALI Port Timing Diagrams

Document ALI-S1002 (8/29/97) illustrates the bit level timing for data transfers with respect the Port Clock on pages 26 and 27. All ALI Port Timing is further explained in Section 6.2**,** Clarification to Science Data Timing (pages 73 - 77).

2.5 Signal Levels

2.5.1 Transmit Levels

Per EIA-422-B, the differential voltage level at the outputs of the ALI RS-422 transmitters shall be between 2.0 and 6.0 volts D.C.

2.5.2 Receive Levels

Per EIA-422-B, received differential signal voltage of greater than +/- 200 millivolts shall cause the receiving devices to correctly assume the intended binary state.

2.6 Signal Grounding and Isolation

Signal, power, and chassis grounds shall be handled in accordance with the specifications contained in the Systems Level Electrical Requirements, New Millennium Program, Earth Orbiter-1 Flight. Signal and power grounds return to a single point ground contained within the PSE of the spacecraft. Signal ground is referenced to chassis ground at the output of the secondary power converter of the relevant subsystem.

2.7 Handling Procedures

2.7.1 ESD Precautions

Standard ESD precautions defined at the higher assembly levels for the ALI, the WARP and Instrument FODB terminal apply to this interface.

2.7.2 Connector Installation and Removal

Policies set forth in the I&T plan shall determine the procedures for connector installation and removal.

2.7.3 Maximum Number of Mate-Demates

During testing, connector savers shall be used. The number of mates-demates between the flight harness and the Instrument FODB terminal (or the WARP RS-422 interface) shall be limited to no more than TBD. Policies set forth in the I&T plan shall determine the maximum number of mate-demates.

2.8 EMI/EMC/RFI Specifications and Procedures

The RS-422 interface shall conform to the EMI/EMC/RFI specifications and procedures contained within the Systems Level Electrical Requirements, New Millennium Program, Earth Orbiter-1 Flight document.

3 DATA LINK LAYER

3.1 Data Link Layer Function

The Data Link Layer defines the basic data units, referred to as words, lines or frames, which are present on the interface and ensures that they are transmitted with minimal errors from the source to the destination. The words are created by adding headers to the data at the source which are recognized by the Data Link Layer service in the receiver. These words are required for data transfer management. The other principal function of this layer is flow control: managing the volume of data from source to destination so as to prevent overflow or underflow of the buffers on either end. Both flow control and error control require acknowledgment from receiver to source, and this acknowledgment scheme is defined at this layer.

3.2 Data Unit (Word) Definition

3.2.1 Word Data Area Size

The standard data unit of the ALI RS-422 interface consists of two 12-bit pixels and an 8-bit header. Data bit 0 (DB0) is the most significant bit (MSB)of pixel #1; DB11 is the least significant bit (LSB) of pixel #1; BD12 is the MSB of pixel #2; DB23 is the LSB of pixel #2. The header data spans DB24 through DB31. Figure 4, shown below, illustrates the ALI word format.

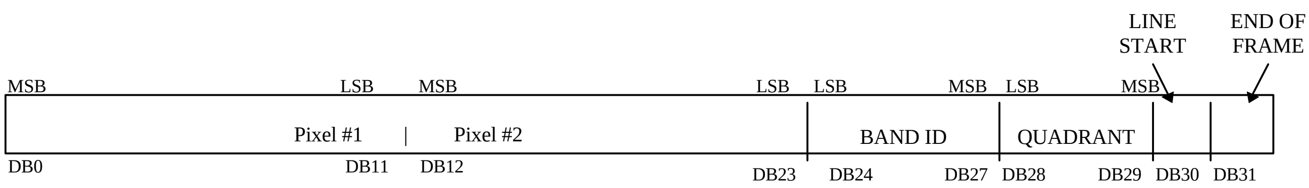


Figure - 4 ALI Word Format

3.2.2 Word Header Definition

Portions of the science data word header are used to control data flow into the FODB or WARP interfaces. The science data word header is defined in Document ALI-S1002, page 40 . The science data word header is briefly described below.

WIS/GIS SWIR: Ports 3 & 5
The BAND ID, bits 24-27, is a 4-bit pattern which indicates that data's source and is static during data transmission.
The QUADRANT ID, bits 28 and 29, is a 2-bit pattern which identifies the specific quadrant for data which propagates through each WIS/GIS SWIR data port. The QUADRANT ID changes with each port clock and sequentially cycles through a count of 0 to 3.

LINE START (DB30) goes high on the first valid bit for each quadrant and is high "1" for a count of 4 data port clock cycles.

END OF FRAME (DB31) goes high at the end of the integration period (several cycles before the first valid data bit of quadrant 1), and remains high until the last valid data word of quadrant 4.

WIS/GIS VNIR: Ports 2 & 4
The BAND ID, bits 24-27, is a 4-bit pattern which indicates that data's source and is static during data transmission.

The QUADRANT ID, bits 28 and 29, is a 2-bit pattern which identifies the specific quadrant location for data which propagates through each WIS/GIS VNIR data port. The QUADRANT ID changes with each port clock and sequentially cycles through a count of 0 to 1. During data reads, DB29 is static false "0" and DB28 toggles on each data port clock cycle.

LINE START (DB30) goes high on the first valid bit for each quadrant and is high "1" for a count of 2 data port clock cycles.

END OF FRAME (DB31), goes high on at the end of the integration period (several cycles before the first valid data bit of quadrant 1), and remains high until the last valid data word of quadrant 2.

MS/PAN: Port 1
The MS and PAN data are read out through the same ALI data port. The BAND ID, bits 24-27, is a 4-bit pattern which indicates that data's source and is static during data transmission. There are 9 discrete patterns which identify the MS BAND. The ALI identifies its 3 discrete PAN BANDs with the same pattern..

The QUADRANT ID, bits 28 and 29, is a 2-bit pattern which identifies the specific sensor collection assembly (SCA) for data which propagates through MS/PAN data port. The QUADRANT ID changes with each port clock and sequentially cycles through counts 0 through 3: MS SCAs are counts 0 and 1; PAN SCAs are counts 2 and 3. The SCA ID's are listed in Figure 19, page 40 of ALI-S1002 ICD.

LINE START (DB30) goes high “1” on the first valid data word of MS and PAN scene . The MS/PAN data format varies based upon science commanding and there is no way to determine whether the first transmitted word will be MS or PAN data. Header bits DB28 and DB29 must be used with DB30 and DB31 to distinguish valid MS data words from valid PAN data words.

END OF FRAME (DB31):
MS: goes high at the end of the integration period (several cycles before the first valid data word of SCA 1), and remains high until the last valid pixel data of SCA4. DB31 indicates the end of the MS/PAN data.

PAN: goes high at the end of the integration period of SCA1, and remains high until the last valid data word of SCA4.

END OF FRAME (DB31) logically “ANDED” with LINE START (DB30) yields the first pixel for MS and PAN data. DB29 distinguishes whether the first pixel is MS or PAN. DB29=1 identifies the first PAN pixel and DB29 = 0 identifies the first MS pixel.

3.3 Data Unit Timing and ALI Frame Definition

Data unit timing diagrams, relative to the appropriate port clock, are illustrated in Document ALI-S1002, pages 26 and 27. WIS/GIS SWIR port clocks are each 9.6 MHz. WIS/GIS VNIR port clocks are each 4.8 MHz. The MS/PAN port clock is 3.2 MHz.

ALI port frames consist of numerous words, excluding the science data header. Document ALI-S1002, pages 31-39 defines the frame structure for each ALI port.

4 APPLICATION LAYER

4.1 Application Layer Function

The Application Layer is the most abstract level of the data. The data here represents the contents of the actual science data that is issued from the ALI and retained by the FODB/WARP interfaces.

4.2 Science Data Content and Formatting

The WARP and Instrument FODB Terminal shall remove each science data header, except the MS/PAN, and insert a 96 bit frame synchronization pattern/counter at the beginning of each frame. The frame synchronization pattern identifies the first pixel from the first quadrant for each ALI frame, except the MS/PAN, and appends a 24 bit frame counter. For the MS/PAN, the frame synchronization pattern identifies the first pixel from the MS’s SCA 1. Document ALI-S1002, Section 6 - Clarification to Science Data Timing, contains a more detailed explanation of ALI data word format, integration timing, frame line timing, and data port timing. Pages 31-30 of Document ALI-S1002 illustrates each ALI port’s data format. The WARP to Ground ICD contains the downlinked science data format.

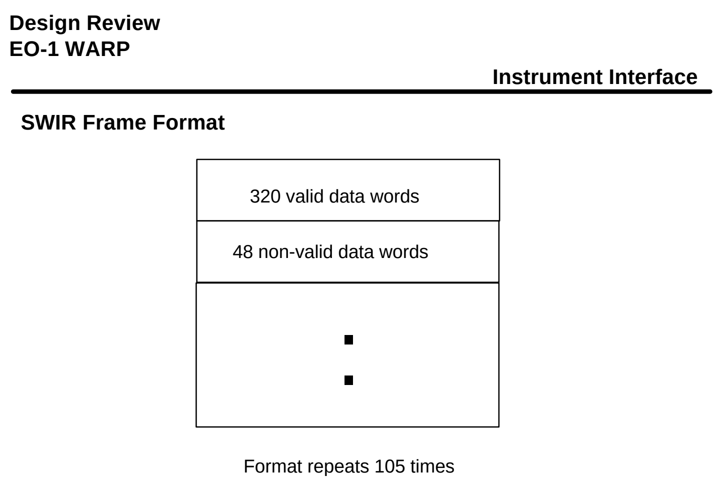
When the END OF FRAME header bit (DB31) is true, all ALI port data is not valid. Every valid frame contains “dead words” which are identified in the Science Data Format as ODDREF/EVENREF words for the MS/PAN format and NO DATA words for the VNIR and SWIR. WIS and GIS dead words shall not be recorded. MS and PAN dead words shall be recorded. The WARP or the Instrument FODB Terminal shall count port clocks and disregard "dead word" counts. The ALI MS/PAN frame (line) rate range supported by the WARP and Instrument FODB Terminal is from 182 to 239 frames per second. The nominal frame (line) rate supported is 226 frames per second.

WIS/GIS SWIR: Port 3 & 5

The SWIR focal plane arrays consist of 320 pixels in the spatial direction and 210 pixels in the spectral direction. The pixels are distributed over 4 quadrants, each with a dimension of 105 by 160 pixels. Two 12-bit pixels are read out of the four quadrants sequentially on each valid port clock cycle. The WARP and Instrument FODB terminal shall insert a 96 bit frame synchronization pattern/counter to identify the first pixel from the first quadrant for each WIS/GIS SWIR frame. The port clock frequency is 9.6 MHz.

Within each frame, non-valid words are interspersed with the valid data. The science data header bits DB31 and DB30 and a custom word counter will be used by the WARP and the Instrument FODB Terminal to filter "dead words" from the received ALI data. Data is received from the ALI in 320 valid data port clock samples followed by 48 invalid data port clock samples. Figure 5 illustrates the SWIR valid/dead word pattern. The WARP RS-422 and the Instrument FODB Terminal will filter, i.e. - not record, the 48 invalid data port clock samples. The 320 valid data port clock samples equate to 80 counts for each of the four quadrants (320 = 80*4). The 48 invalid data port clock samples equate to 12 counts for each of the four quadrants (48 = 12*4). The pattern repeats until 105 valid data blocks, one for each line, is read out (after data format count number 9648). A total of 38592 (105*320+104*48) data port clock cycles are required to read a single data frame. DB31 goes low "0" at the end of a frame, when the data is not valid.

Figure 5



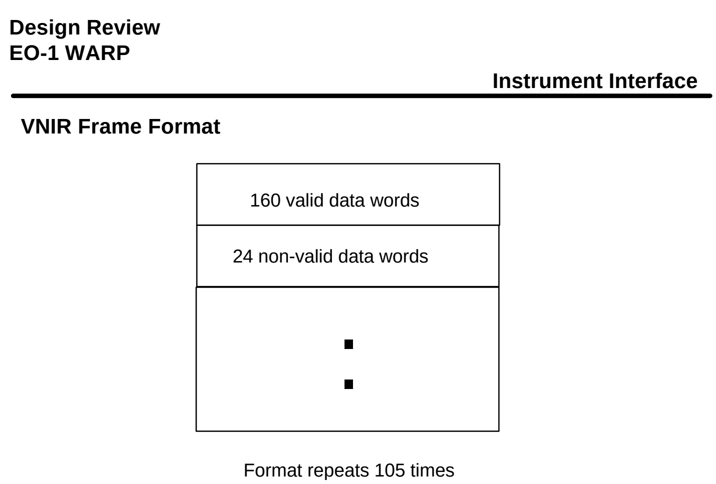
WIS/GIS VNIR: Ports 2 & 4

The SWIR focal plane arrays consist of 320 pixels in the spatial direction and 105 pixels in the spectral direction. The pixels are distributed over 2 quadrants, each with a dimension of 105 by 160 pixels. Two 12-bit pixels are read out of the four quadrants sequentially on each valid port clock cycle. The WARP and Instrument FODB Terminal shall insert a 96 bit frame synchronization pattern/counter to identify the first pixel from the first quadrant for each WIS/GIS SWIR frame. The port clock frequency is 4.8 MHz.

The science data header bits DB31 and DB30 and a custom word counter will be used will be used by the WARP and the Instrument FODB Terminal to filter “dead words” from the received ALI data. Within each frame, non-valid words are interspersed with the valid data. Data is received from the ALI in 160 valid data port clock samples followed by 24 invalid data port clock samples. Figure 6 illustrates the VNIR valid/dead word pattern. The WARP and the Instrument FODB Terminal will filter, i.e. - not record, the 48 invalid data port clock samples.

The 320 valid data port clock samples equate to N=80 counts for each of the four quadrants. The 48 invalid data port clock samples equate to N=12 counts for each of the four quadrants (48 = 12*4). The pattern repeats until 105 valid data blocks, one for each line, is read out. A total of 19296 (105*160+104*24) data port clock cycles are required to read a single data frame. The WARP and the Instrument FODB Terminal will filter, i.e. - not record, the 48 invalid data port clock samples. DB31 goes low “0” at the end of a frame, when the data is not valid.

Figure 6



MS/PAN: Port 5

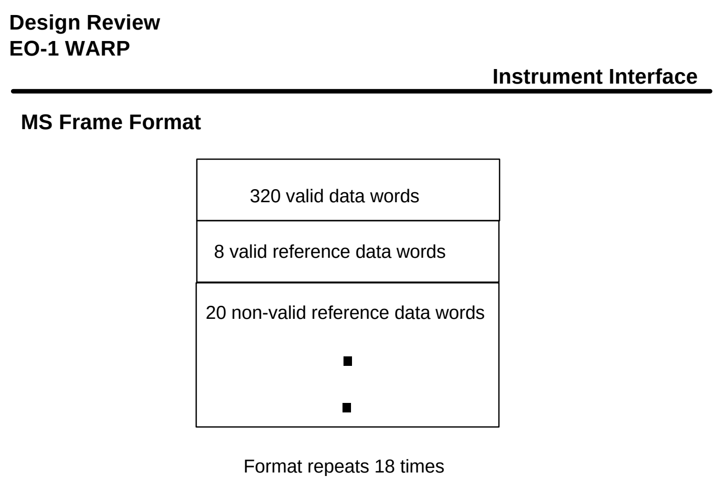
The MS and PAN data are multiplexed and transmitted to the WARP\FODB interfaces through a single ALI data port. PAN data is read out three times per frame. MS Data is read out once per frame. For each FPE master clock cycle, two MS data words are output followed by two PAN words. Relative alignment of the MS and PAN data streams, varies based upon science commanding and there is no way to determine whether the first transmitted word will be MS data (or PAN). See Section 3.2.2's MS/PAN Word Header Definition. Timing diagrams are located in Document ALI-S1002 (pages 31-30). The following two sections describe the MS and PAN formats.

MS:
The MS focal plane arrays consists of 4 SCA's with 320 pixels in each of 9 bands. Four reference pixels are associated with each SCA and each band. Two 12-bit pixels are read out of two SCAs sequentially on each valid MS port clock cycle. The port clock frequency is 3.2 MHz.

MS data is read out once per frame. Within each frame, non-valid words are interspersed with the valid data. Data is received from the ALI in 328 valid data port clock samples followed by 20 invalid data port clock samples. The WARP and the Instrument FODB Terminal will record the 20 invalid data port clock samples. The pattern repeats twice for each band. Figure 7 illustrates the MS valid/dead word pattern. A total of 6244 (9 bands *2 blocks/band *328 clocks/block + 8 bands*2 blocks/band*20 clocks/block +1band*20 clocks) data cycles are required to read out the data frame.

The data header bits 24 through 27 indicate the band currently read out and changes state 9 times throughout the data readout period. END OF FRAME (DB31) is not a true data valid bit and should be used to indicate the end of the data. DB30 goes high on the first valid data bit for each SCA pair and is high for 2 data port cycles. DB31 goes low "0" at the end of a frame, when the data is not valid. QUADRANT ID, DB28 and DB29, identify the currently accessed SCA. DB29 is static false throughout the data read and DB28 toggles on each port cycle.

Figure 7

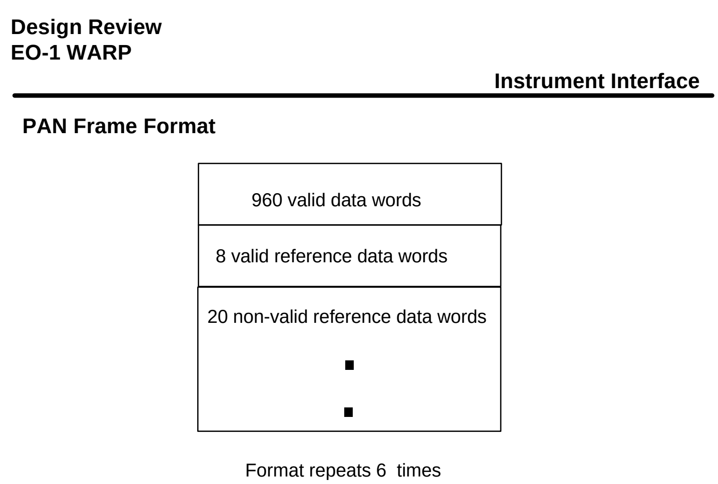


PAN:
The PAN focal plane array consists of 4 SCA's, each with 960 pixels. Four reference pixels are associated with each SCA and each band. Two 12-bit pixels are read out of two SCAs sequentially on each valid PAN port clock cycle. The port clock frequency is 3.2 MHz.

PAN data is read out three times per frame. Within each frame, non-valid words are interspersed with the valid data. Data is received from the ALI in 968 valid data port clock samples followed by 20 invalid data port clock samples. The WARP and the Instrument FODB Terminal will record the 20 invalid data port clock samples. Figure 8 illustrates the PAN valid/dead word pattern. The cycle repeats two times for each scene readout, or a total of 6 times during a frame. The WARP and the Instrument FODB Terminal will record the 20 invalid data port clock samples

The data header bits 24 through 27 identify which of the 3 PAN cycles is currently read out. LINE START (DB30) and END OF FRAME (DB31) toggle three cycles each frame, once for each image. DB31 goes high at the end of the integration period, several cycles before, the first valid data bit of SCA 1, and remains high until the last valid data bit of SCA 4. DB30 goes high on the first valid data bit for each SCA and is high for a 2 data port cycles. DB31 goes low "0" at the end of a frame, when the data is not valid. QUADRANT ID, DB28 and DB29, identify the currently accessed SCA. DB29 is static true throughout the data read and DB28 toggles on each port cycle.

Figure 8



Date: Tue, 20 Jan 1998 17:06:18 -0500 (Eastern Standard Time)
From: Administrator@hst-nic.hst.nasa.gov
Reply-to: (Wes Powell, Code 561)
Subject: CCR:0006 - DUE: 02/13/98   ROUTINE Level-2 Wes Powell, Code 56 WWW-COMMENTS

USER :   (Wes Powell, Code 561) sent the following comments on :

\---
Date: 01/20/1998
CCR Number: 0006
Sponsor: T. Smith/Code 735
Due Date: 02/13/98
\---
CCR Title: BASELINE ALI TO EO-1 SPACECRAFT RS-422 DATA ICD-056
\---
Remote host: 128.183.147.130 Email Address:
\---
APPROVAL STATUS: APPROVED
Note:
\---
COMMENTS:

EO-1 CCR SPONSOR RECOMMENDATION FORM

CCR NUMBER: 0006

CCR TITLE: BASELINE ALI TO EO-1 SC RS 422 ICD 056

CCR SPONSOR: T. Smith

SUMMARY OF COMMENTS RECEIVED: (list Level 4 CCB and internal reviewers who had comments and address those comments)

NONE

DATE: 3/26/98

SPONSOR RESPONSE: Approve as written

SPONSOR/ORGANIZATION: Terry Smith
DATE: 3/26/98